2007 Clean Cities Northeast and Mid-Atlantic Regional Peer Exchange

June 27th

Hoon Ge

Definition of Biodiesel

- Chemically
  - Mono Alkyl Ester
- Functionally
  - Surrogate for petroleum distillates
- Nomenclature
  - B100 = 100% pure Biodiesel, AKA “neat”
  - B20 = 20% Biodiesel & 80% petroleum diesel

Making Biodiesel

(Catalyst)

100 pounds Triglyceride	+ 10 pounds Alcohol	=	10 pounds Glycerin	+	100 pounds Mono-Alkyl Esters
Soy oil	Methanol				Biodiesel

- Raw Vegetable Oil is NOT Biodiesel!
- Other 'biomass' products aren't Biodiesel
- Must meet ASTM D 6751

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BIODIESEL®

Biodiesel Raw Materials

Oil or Fat

- Soybean
- Corn
- Canola
- Cottonseed
- Sunflower
- Beef tallow
- Pork lard
- Used cooking oils

Alcohol

- Methanol
- Ethanol

Catalyst

- Sodium hydroxide
- Potassium hydroxide

Biodiesel Attributes

- High Cetane (avg. over 50)
- Ultra Low Sulfur (avg ~ 2 ppm)
- High Lubricity, even in blends as low at 1-2%
- High Energy Balance (3.2 to 1)
- Low Agriculture Inputs: Soybeans
- 78% Life Cycle C02 Reduction
- Renewable, Sustainable
- Domestically Produced
- Reduces HC, PM, CO in existing diesel engines
- Reduces NOx in boilers and home heating

Biodiesel ASTM D6751

Property	ASTM Method	Limits	Units
Calcium & Magnesium, combined	EN 14538	5 max ppm	(ug/g)
Flash Point (closed cup)	D 93	93 min.	Degrees C
Alcohol Control (One of the following must be met)			
Methanol Content	EN14110	0.2 Max	% volume
Flash Point	D93	130 Min	Degrees
Water & Sediment	D 2709	0.05 max.	% vol.
Kinematic Viscosity, 40 C	D 445	1.9 - 6.0	mm2/sec.
Sulfated Ash	D 874	0.02 max.	% mass
Sulfur			
S 15 Grade	D 5453	0.0015 max. (15)	% mass (ppm)
S 500 Grade	D 5453	0.05 max. (500)	% mass (ppm)
Copper Strip Corrosion	D 130	No. 3 max.	
Cetane	D 613	47 min.	
Cloud Point	D 2500	Report	Degrees C
Carbon Residue 100% sample	D 4530*	0.05 max.	% mass
Acid Number	D 664	0.50 max.	mg KOH/g
Free Glycerin	D 6584	0.020 max.	% mass
Total Glycerin	D 6584	0.240 max.	% mass
Phosphorus Content	D 4951	0.001 max.	% mass
Distillation, T90 AET	D 1160	360 max.	Degrees C
Sodium/Potassium, combined	EN 14538	5 max	ppm
Oxidation Stability	EN 14112	3 min	hours

Tested Property	Method/Instrument	Importance
Calcium, Magnesium combined	Atomic Absorption Spectrometry	Help prevent deposits in the fuel system.
Flash Point	Pensky-Martens (closed cup) Apparatus	Fire safety, ensure excess methanol has been removed.
Water and Sediment	Centrifugation	Prevent corrosion and proliferation of organisms.
Kinematic Viscosity, 40C	Glass Capillary Viscometer	Help ensure satisfactory fuel combustion.
Sulfated Ash	Superheated Air-Jet Block	Prevent injector deposits, ensure removal of catalyst.
Sulfur Content	Mass Spectrometry	Protect exhaust catalyst system.
Copper Strip Corrosion	Submerged Copper Strip Color Change with applied heat	Indicates difficulties with bronze and copper vehicle components.

Tested Property	Method/Instrument	Importance
Cetane	Cetane Engine or 4-variable Equation	Measures ignition quality.
Cloud Point	Chilled Glycol Bath	Helps determine cold weather performance.
Carbon Residue (100% sample)	Superheated Steam Bath	Helps prevent engine deposits.
Acid Number	Titration with KOH	Helps prevent engine deposits.
Free and Total Glycerin	Gas Chromatography	Helps prevent storage tank, fuel system, engine fouling and filter plugging.

Tested Property	Method/Instrument	Importance
Phosphorus Content	Quantitative Determination by ICP	Protect catalytic converters.
Distillation, T90	Distillation	Ensures that fuels have not been contaminated with high-boiling materials such as used motor-oil.
Sodium, Potassium combined	Atomic Absorption Spectrometry	Help prevent deposits in the fuel system.
Oxidation Stability	Accelerated Oxidation Test	Indicates oxidative stability.
Workmanship	Visual Inspection	Indicates visible water, sediment, and suspended matter.

BQ-9000 Quality Program

- Accreditation or Certification given by the National Biodiesel Accreditation Commission under NBB.
- Helps to ensure that the facility produces or markets high quality product, and should be used to market this high level of quality to customers.
- There are currently 7 BQ-9000 accredited marketers and 19 accredited producers.

BQ-9000 Required Testing

- Flash point, °C
- Water and Sediment, volume %
- Cloud point, °C
- Acid number, mg KOH/gm
- Free glycerin, % mass
- Total glycerin, % mass
- Sulfur, ppm
- Stability, hr
- Visual appearance

BQ-9000
"Quality Assurance Program"

This program "specifies requirements for a quality assurance program where an organization needs to demonstrate its ability to provide product that meets ASTM D 6751, Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels and applicable regulatory requirements, and address quality assurance through the effective application of the program, including processes for corrective action and the prevention of nonconformity."

BQ-9000 Initial Registration

- Complete the Application
  - Submit Quality Manual
  - Pay $750 application fee
  - Provide proof of EPA Registration
- The Commission reviews the application and application materials
  - Applications considered administratively complete shall be accepted for processing and audit
  - $ 2,500 Certification Audit Fee
- An independent auditor is assigned, shall establish the audit schedule with applicant.
  - Desk audit to verify written compliance
  - On-site audit to verify compliance. Any corrective actions must be addressed within 30 days.
- The Commission reviews results of audits, votes on the company's status.
- If applicant passes audit, Commission grants accreditation for 2 years.

BQ-9000 Information Through the NBB

http://www.bq-9000.org/

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BIODIESEL

ALWAYS BUY PRODUCT FROM BQ-9000 CERTIFIED PRODUCERS OR MARKETERS!!!

Materials Compatibility

- B100 may adversely affect some elastomers such as natural or nitrile rubbers over time.
- Most elastomers used after 1993 are compatible with B100 (Viton/Teflon).
- Blends (B20) effect is less, or non-existent.
- Normal monitoring of hoses and gaskets for leaks is sufficient with B20.
- Consult with your parts supplier or mechanical engineering partners.

Materials Compatibility

- Biodiesel and biodiesel blends will form high sediment levels when in contact with the following metals:

  -Brass, Bronze, Copper, Lead, Tin and Zinc

- Biodiesel is compatible with:

  -Mild and Stainless Steel, Aluminum

Hardness and Swell

Material	Effect of Biodiesel
Teflon	Little change
Nylon 6/6	Little change
Nitrile	Hardness >20% Swell <18%
Viton A401-C	Little change
Viton GFLT	Little change
Fluorosilicon	Little change in hardness Swell >7%
Polyurethane	Little change in hardness Swell >6%
Polypropylene	Hardness <10% Swell >8-15%

Biodiesel Distribution

- Pipeline
- Terminal
- Fuel Distributors
- Retail

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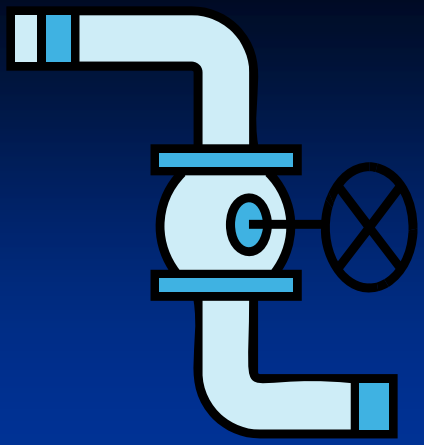
BIODIESEL



Pipeline

- Colonial Pipeline
  - B5 test
  - Jet fuel contamination

Terminals

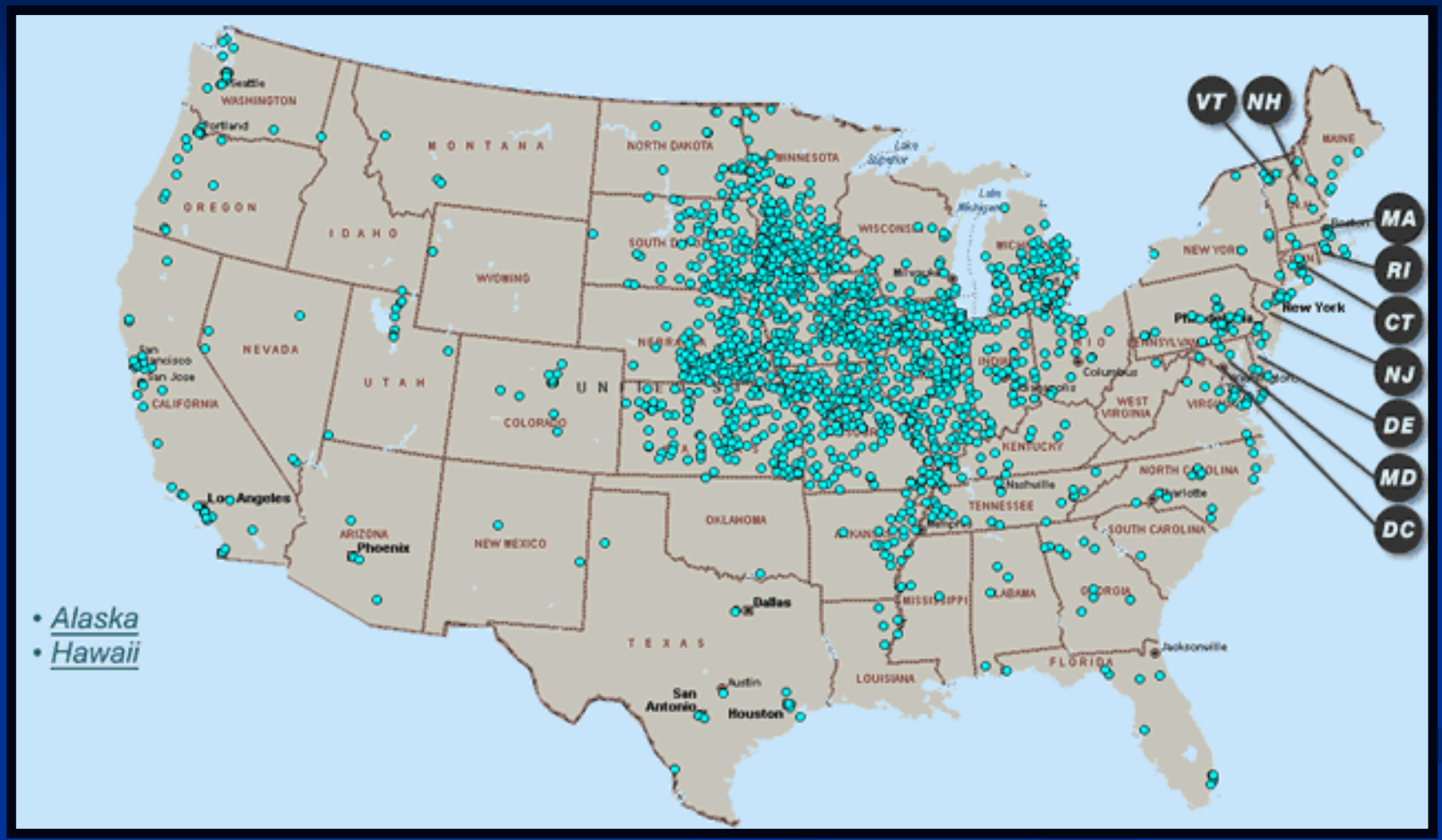
- ***Optimal* way to distribute biodiesel**
  - blending accuracy

- Minnesota  7
- North Dakota  2
- Iowa  2
- Texas  2
- Indiana  3
- New York  1

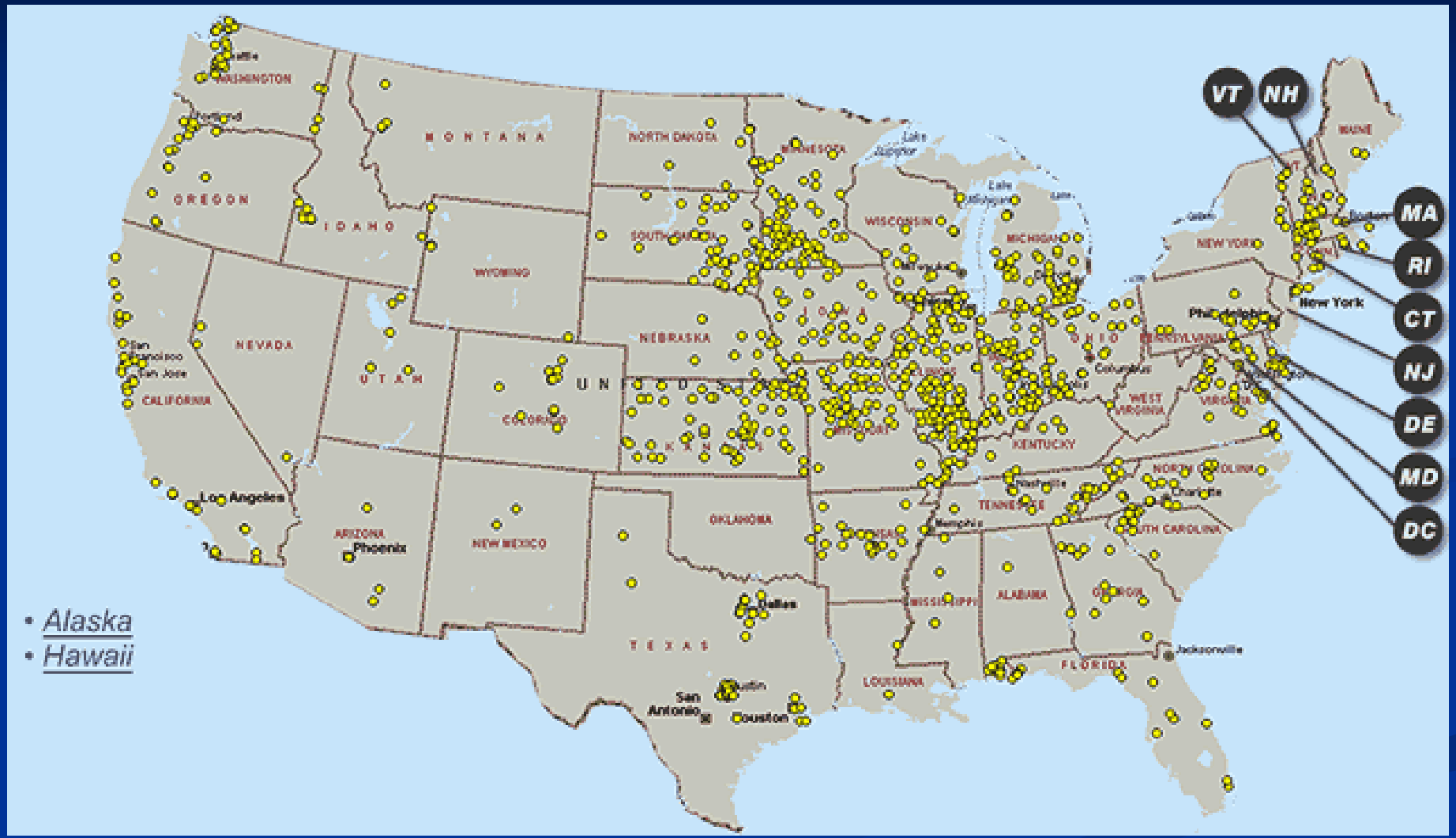
- Missouri  1
- Mississippi  1
- Florida  1
- Illinois  1
- Wisconsin  1

Biodiesel Distributors in the US

(As of Sept. 7, 2006)



Biodiesel Retail Fueling Sites



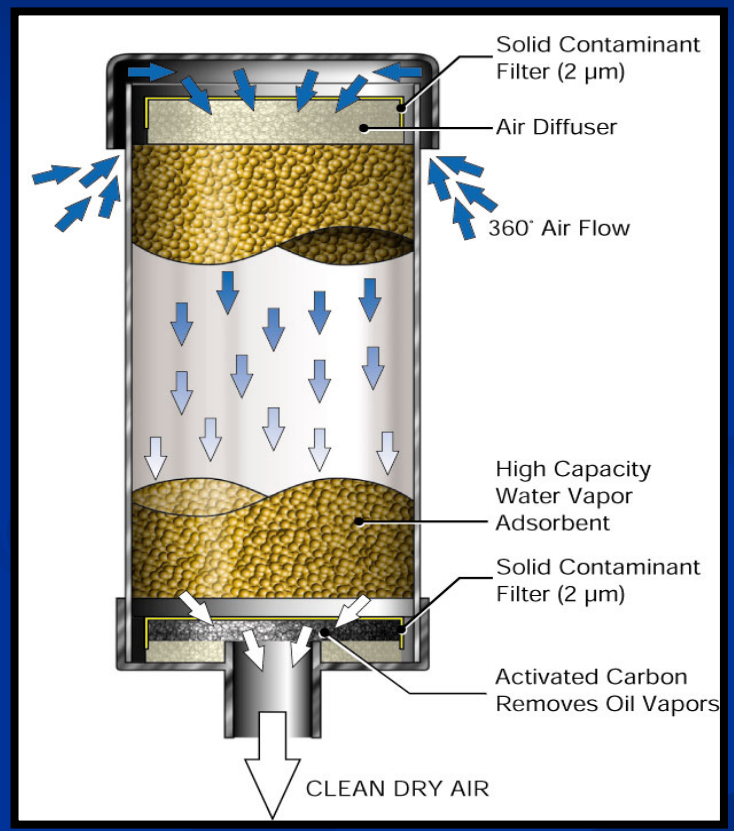
Housekeeping
Petrodiesel and Biodiesel

- No matter where you are in the supply chain both you and your staff are responsible for ensuring optimum storage environments for your fuels.

- The three basic ways which fuel may become contaminated are air, water and the fuel itself.

Exposure to Air

- Enters through vent pipes and contains large amounts of moisture.
- Generally displaces the fuel as tank is emptied.
- It is not practical to keep air from entering the tank.
- Will increase the oxidation of fuel.
- Do not store fuels for long periods of time in partially empty tanks without stabilizers.
- Consider desiccant dryers.



Water

- Free water in the fuel system accelerates corrosion and fuel degradation, it can also create a fertile growing place for “bugs.”
- Poor tank design has made complete removal of water impossible.
- Enters mostly as condensation from air. Vents and seals that are poorly constructed or maintained can allow water to infiltrate

  the storage tank.

Maintaining Your Fuel Quality

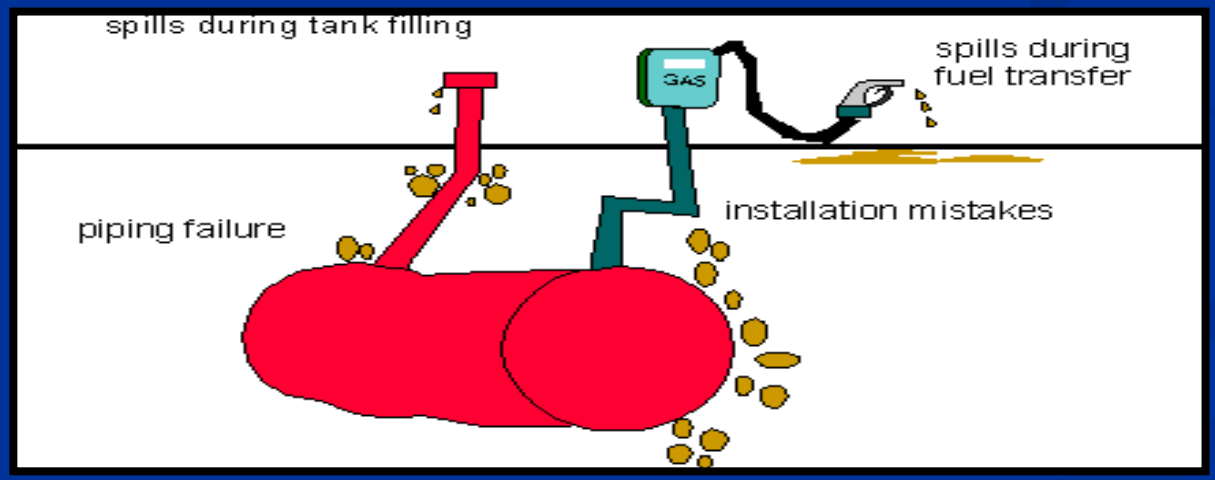


- Begin by specifying ASTM designed fuels, D6751 and D975.
- Reference cold weather performance and other special needs prior to ordering.
- Be proactive with general housekeeping practices.
- Maintain optimum storage conditions.
- Execute a quarterly fuel analysis program to ensure good preventative measures.

Storage Tank Challenges

Distribution chain storage tanks create a challenging maintenance process.

- Improper placement of water draw off
- Lack of attention to water evaluation, electronically or physically sticking tank with water paste
- Sticking before and after each fuel delivery



Benefits: Biodiesel and ULSD

- Compatible with the compression ignition platform and with diesel fuel itself
- Greatly enhances lubricity of ULSD
- Compatible with 2007 diesel engine catalysts
- Aids with ULSD conductivity issues
- Reduces harmful emissions
- Power and performance virtually unchanged
- Seamless & transparent with existing petroleum infrastructure, (liquid not gaseous)
- Promotes national energy security
- Renewable, non-toxic, green blend stock option

ULSD & Lubricity

- Sulfur compounds are natural lubricants in diesel.
- ULSD regulations are causing major concerns with diesel engine performance.
- ASTM lubricity requirement effective Jan 1, 2005 for diesel fuels.
- ASTM D 6079

  -High Frequency Reciprocating Rig (HFRR)

  -Wear Scar Maximum = 520 micrometers

Biodiesel Adds Significant Lubricity to ULSD

	% Biodiesel	Results (microns)
#2 ULSD	none	580
	B2	278
	B5	260
#1 ULSD	none	680
	B2	380

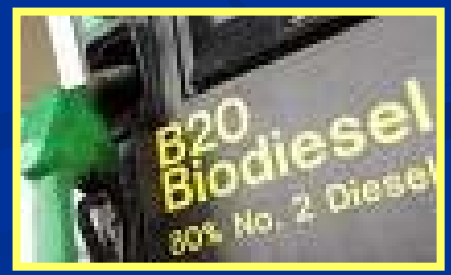
- These results were obtained by ASTM 6079, HFRR lubricity test.

CFPP Testing of ULSD B2 Blends

Sample Description	CFPP °F, Base Fuel	CFPP °F w/ Additive
IL ULSD Sample 1	+3	-20
IL ULSD Sample 2	-2	-26
MN ULSD Sample 1	+1	-17
MN ULSD Sample 2	+1	-26
MN ULSD Sample 3	+8	-17
MN ULSD Sample 4	0	-26

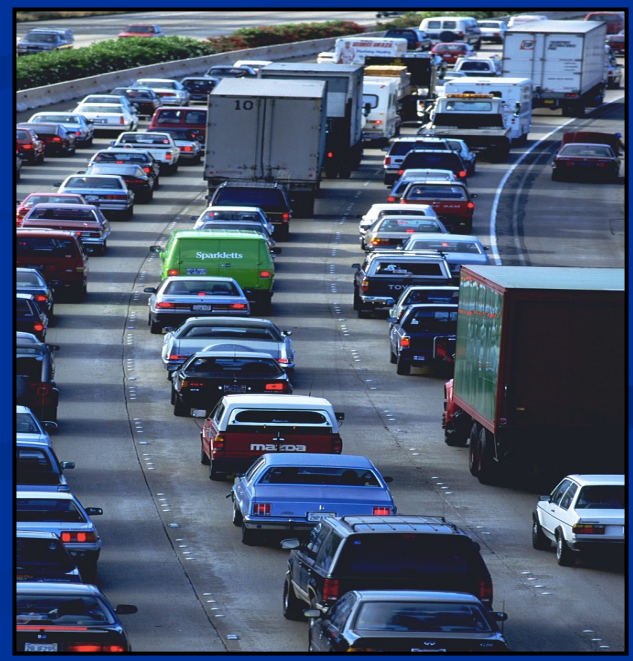
ULSD and Biodiesel

- Biodiesel is slightly heavier than petroleum diesel with a gravity value of 0.88 versus 0.85.
- Biodiesel should be introduced after diesel fuel and should be agitated in the tank during splash blending procedures.
- Storage and blending of B100 should be maintained at +10 degrees F above the B100's cloud and pour point to blend successfully.
- Blends will not separate in the presence of water.



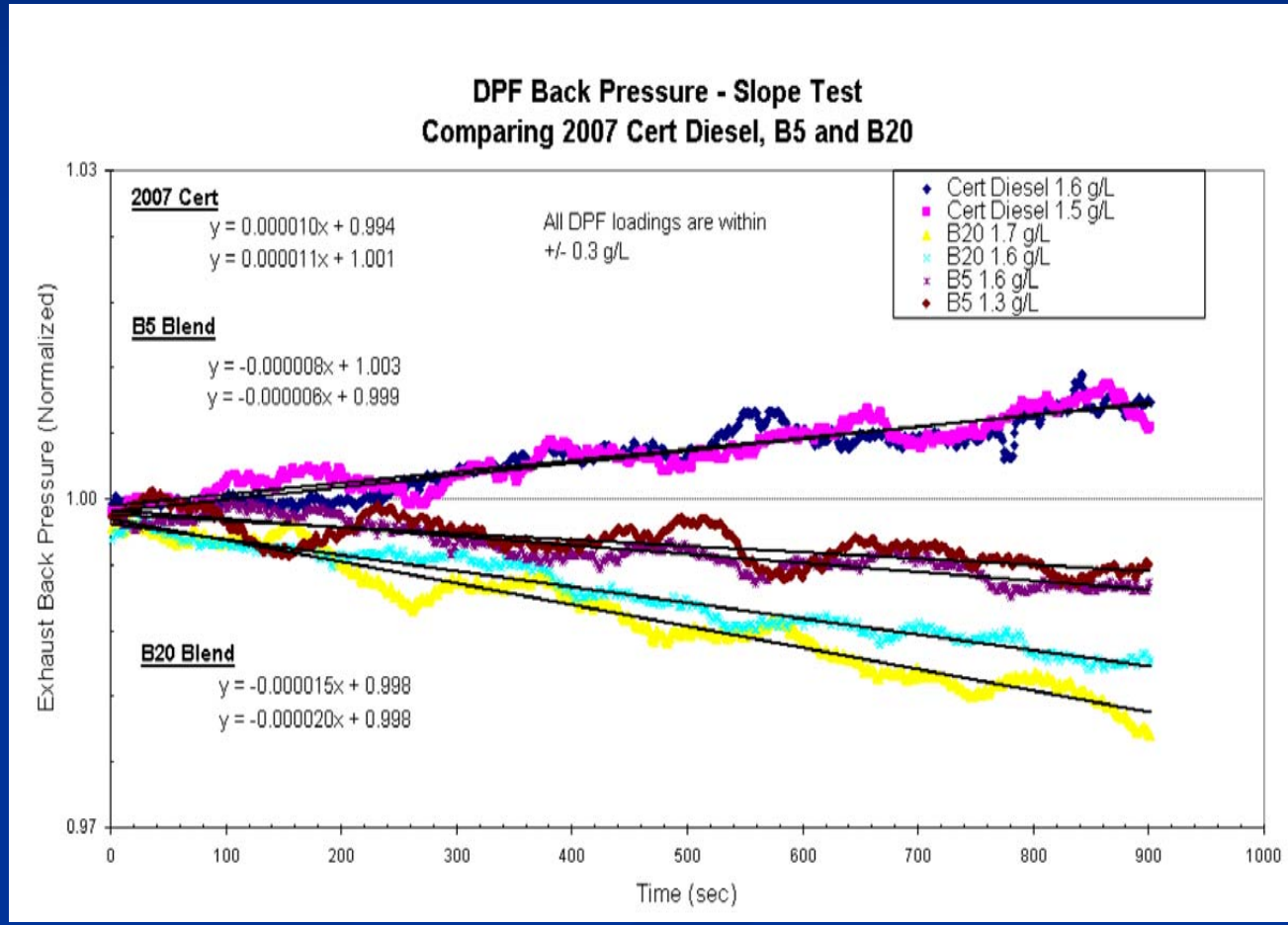
2007 Engines

- EPA regulations require reduced sulfur in diesel fuel for engines being sold starting January 1, 2007.
- 80% of highway diesel fuel must be ULSD (< 15ppm sulfur) beginning June 1, 2006.
- Catalyzed Diesel Particulate Filters can eliminate 99% of solid particles (soot & metals) and eliminate >90% of semi-volatile hydrocarbons.
  Source: EPA



Indicators of DPF Performance

- Filter regeneration rate increased significantly when using blends as low as B5. Lower particulate temperature and less particulate input contributed.



"Biodiesel Effects on Diesel Particle Filter Performance." National Renewable Energy Laboratory, March 2006.

NBB Resources: www.biodiesel.org

- Technical Library
- Biodiesel Bulletin
- Informational Resources
- Technical Resources
- Educational Videos Available
- On-line Database & Spec Sheets

Educational Resources

- BEN: Biodiesel Education Network
- Web-based resource specifically for petroleum marketers
- Partnership between NBB/PMAA
- www.pmaa.org
- www.biodiesel.org